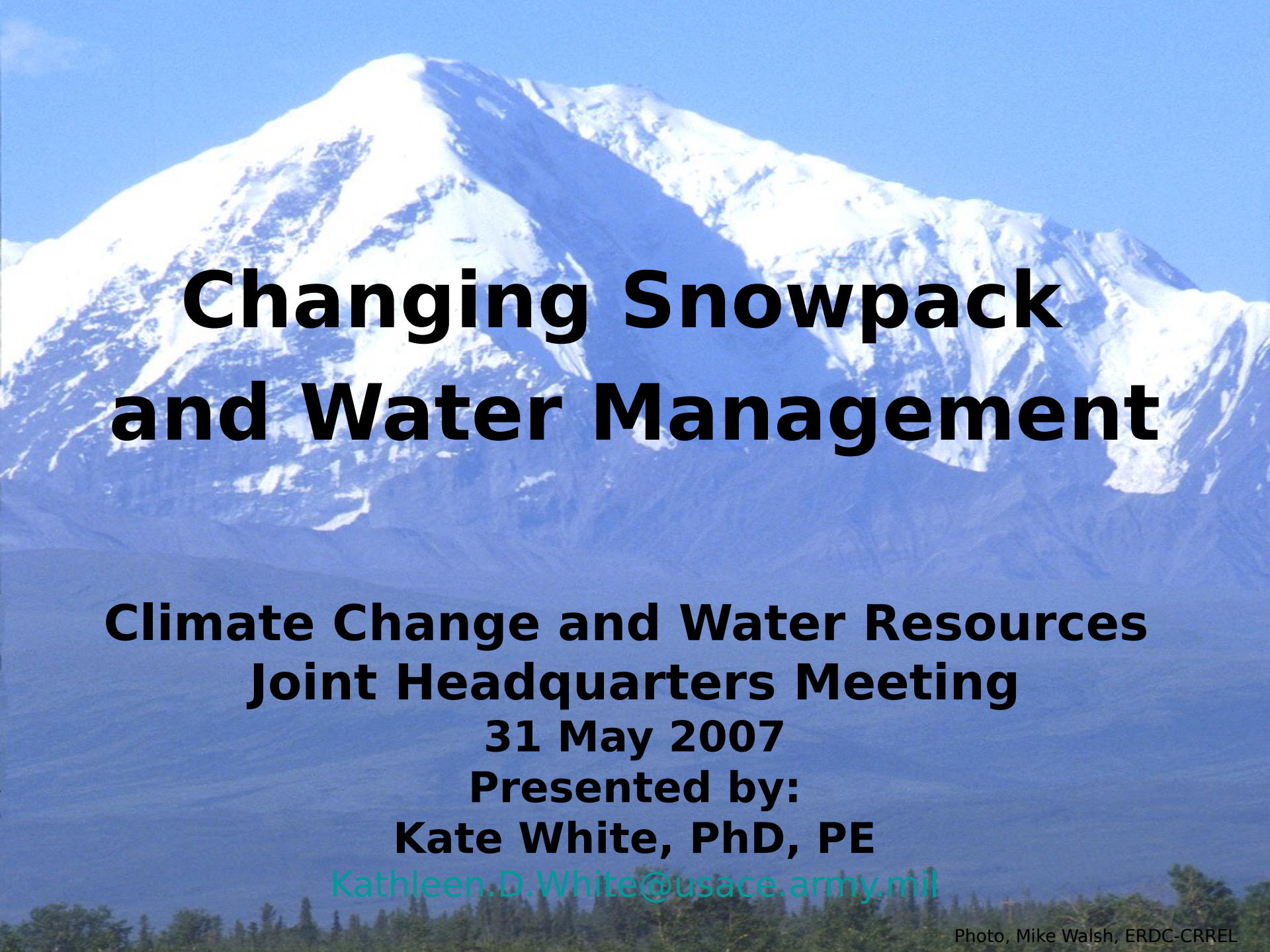




Changing Snowpack and Water Management

**Climate Change and Water Resources
Joint Headquarters Meeting**

31 May 2007

Presented by:

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Corps experiences

- **From Corps Climate Workshop, Nov 2004:**
 - **Baltimore, Sacramento, Detroit, Walla Walla, Seattle, Portland, Fort Worth, Jacksonville, and Galveston Districts, South Atlantic Division, Lakes and Rivers Division**
 - **HQ, ERDC, IWR**
 - **NOAA, NWS, NASA, and USGS**
 - **U Maryland and Washington, Scripps Oceanographic Institute**



Corps experiences

Engineer Update, February 1997

- **Warming is accelerating and will continue**
- **Weather is becoming more energetic and more variable, though specific areas are responding**



The Corps, along with state and local agencies, completed the emergency ring levee around Meridian, Calif., only 100 feet ahead of encroaching flood waters.

differently



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Cayan (Scripps/USGS):

- **Rain vs. snow is crucial to water issues in the West**
 - In CA's Sierra Nevada, only 20-30 days deliver most of the year's water
 - Timing of spring runoff 1-3 wks earlier in decades after 1977
 - Not only early snowmelt but more immediate rainfall runoff occurred
- **Trends have been a response to warming trends (not change in precipitation)**



Dettinger (USGS):

- **Trend of increased temperatures in Pacific Northwest snowmelt-dominated watersheds results in**
 - **increased runoff in winter**
 - **less runoff in summer**
 - **earlier peak snowmelt**
 - **earlier peak runoff in spring**
 - **earlier soil moisture recharge in spring**



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Corps experiences

- **Climate variability is shaping the future of water resources management**
- **Temporal and spatial mismatches of supply and demand are a major problem in water supply**
 - Increased early flood risk
 - Changes in timing and volume of refill
- **Effects on snowpack are a significant driver**



Corps response

- **Grassroots effort by Corps Climate Focus Group**
 - **Survey of western districts to ID climate drivers**
 - Regional temperature shifts
 - Increased variability and uncertainty in forecasts
 - Seasonal timing of large storm events
 - Altered seasonality and volume of precipitation
 - **Surveys ID'd impact pathways:**
 - Water temperature
 - Streamflow timing shifts (shape of hydrograph)
 - Annual runoff volume altered
 - Pattern of snow accumulation and melt
 - Watersheds: snow-dominant vs. rain dominant
 - Altered risks for streamflow extremes (high and low flow)



Corps response

- **Desired improvements in water resources planning and management:**
 - **Flexible Rule Curves and Storage Reservoir Diagrams (SRD)**
 - Changing operations at dams
 - Reservoir evacuation and refill schedules
 - Elevation control of lakes (i.e. Lake Washington)
 - **New Water Control Plans**
 - Changes to reservoir/water allocations and/or prioritization
 - Changing storage needs



Corps response

- **Desired improvements in water resources planning and management:**
 - **Structural design changes**
 - Levees, flood risk reduction
 - Streamflow forecasts
 - **Higher resolution remote sensing**
 - Reduced uncertainty required
 - **Updated decision support tools**
 - **Biological Opinions (BiOp)**
 - Reasonable and prudent alternatives (RPAs) and reasonable and prudent measures (RPMs)
 - Restoration of normative annual hydrographs & thermographs

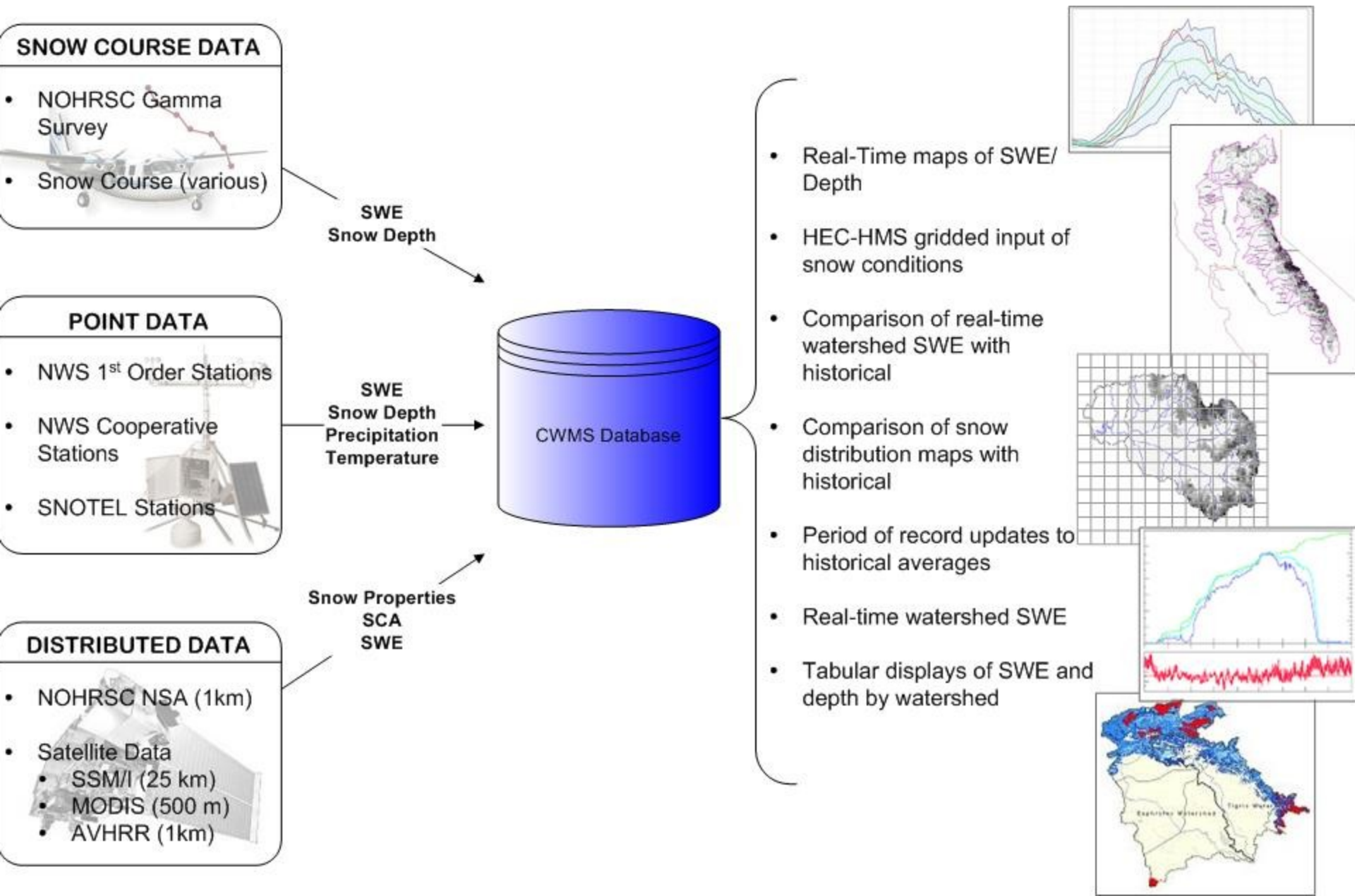


Corps response

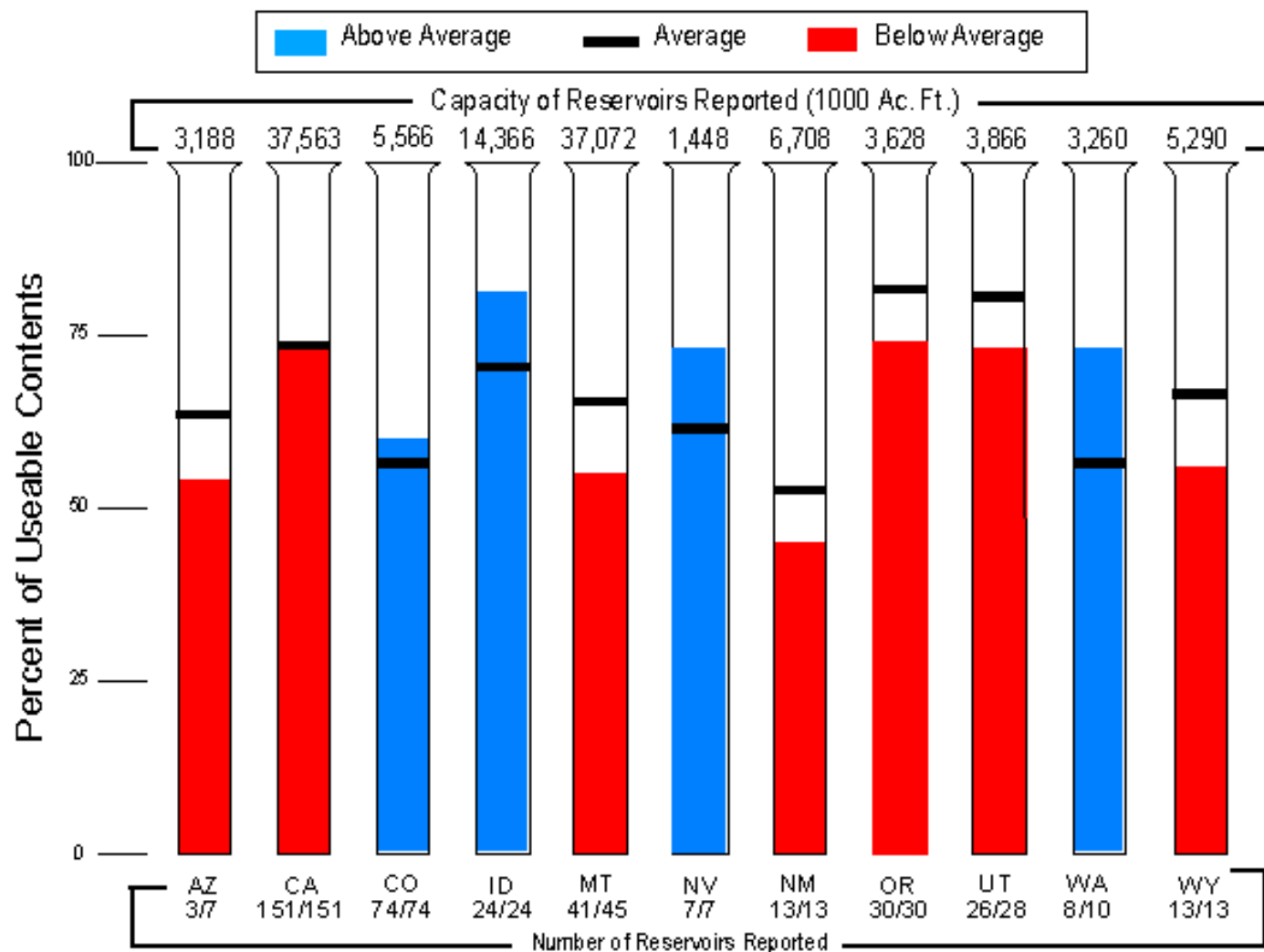
- **Significant climate-related capabilities are emerging that we can integrate and leverage**
 - **Improvements to modeling, e.g., inclusion of ground state and improved snowmelt capabilities in HEC-HMS/Corps Water Management System (CWMS)**
 - **Improved snow monitoring via interagency cooperation**
 - **Develop new tools to support climate variability analysis for studies (12 Actions)**



Goal: Maximize use of interagency data and p



Reservoir Storage as of May 1, 2007



Mountain Snowpack as of May 1, 2007

